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James P. Boyd.

Effects of Cold.

James P. Boyd.

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An
Inaugural Dissertation
On
The Effects of Cold
By (Junior)
James P. Boyd
of
New York

unpublished

the effect of cold

(1844)

James J. Smith

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Effects of Cold

The Subject of Cold, and its effects, has attracted the attention of the most eminent medical men. Its great interest and importance, have given rise to many splendid productions. Impressed with a knowledge of these circumstances, it is with much diffidence, I submit to your inspection, this dissertation; the more so, because I am aware that I can neither improve, nor add any thing, to what has already been presented to the Medical profession, by some of its most distinguished members. A compilation of the facts more worthy of attention, contained in their writings, relative to this interesting subject, is all that can be expected from the student, whose opportunities of observation are necess-

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sarily limited; and whose information therefore is derived chiefly from books.

In the following remarks, I propose, after some general observations on the effects of cold, to consider, first its effects when applied to the whole surface of the body, producing that state called Asphyxia; next its Local effects, or the phenomena exhibited, when only a part of the body is subjected to its influence; and lastly, the treatment.

Cold is now generally considered, as nothing material, but merely the absence of heat in a greater or less degree. With respect to the Human body, it is only a relative expression, and depends altogether on the previous sensations; so that the same degree of heat or cold, at different times, excites quite opposite feelings. This may be illustrated by placing one hand near a fire, or in a vessel of warm water, while the other is in contact with some ice, or other cold substance. If both hands be now immersed into water of the medium temperature of the atmosphere, the sensation

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will be that of cold to the hand that was near the fire; while on the contrary the other will feel warm.

Natural cold is owing to physical causes, over which man has no controul, and which obey the common laws of Nature. The temperature of different countries depends on a variety of circumstances. Elevated situations are colder than those that are less so, although both situated in the same degree of latitude. Cold is modified by the action of the winds, and depends upon the quarter from whence they come. In this part of the globe North winds are always cold, owing to the immense fields of ice, and the mountains situated in the regions from whence they come whose summits are eternally covered with snow-drift winds, on the contrary, passing over the burning regions of the tropics, are of a more elevated temperature.

Cold climates have evidently great influence on the physical character of mankind; thus the repeated observations of travellers have shown. The diminished form of the Laplander has been accounted for in

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this manner. This degraded portion of the human species derives, evidently from the climate, its distinctive characteristics. Storing power with the inviolence of a severe climate, the destructive action of an icy temperature; nature fettered in her motions, shrunk in her dimensions: can produce only, beings, whose physical imperfections explain their almost barbarous condition. In Northern nations, Puberty is protracted to a much later period. The females do not menstruate so soon: nor is that fluid discharged in so great a quantity as in more temperate climates. In Tropical climates, the Catamenia make their appearance at the age of eleven years, and often at a much earlier period, and are discharged in the quantity of six ounces, or more; whereas in Kamtschatka, and other countries of the same temperature the evacuation is not perceived till the age of twenty one, and even then is in small quantity, and at long intervals; and in many instances, only during the Summer months. The females of these

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The natives of Northern countries are endowed with but little sensibility, when compared with the inhabitants of warm climates. It is said by travellers, that in the neighbourhood of the Poles, the natives are so obtuse in their feelings, that they bear the deepest wound without pain. And according to Lixow and Vancouver, the inhabitants on the North coast of that Continent, thrust sharp pieces of glass into their feet without feeling the slightest uneasiness from it. Whereas, the slightest prick from a thorn often produces in an African, or a native of any other Southern part, violent convulsions, and tetanus.*

The influence of cold is also visible on the inferior animals, and vegetables; hence the stunted appearance of the individuals of both these kingdoms of Nature in Northern climates. Those animals that are unable to endure, or to exist in, an atmosphere, whose temperature is below the freezing point of water, have recourse to such places of abode in winter,

* Richardson's Physiology

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as are protected from the severity of the climate. Some bury themselves in the Earth, and these pass the winter in a state of torpidity. The fish betake themselves to deep waters, while the feathered tribes wing their way, to a more congenial sky. The different genera of the inferior animals, are found, we see, in situations adapted respectively to their constitutions, and are protected from cold by natural coverings suited to their different conditions. Hence we find, that the animals of the torrid zone, are covered with hair: those of a more temperate climate, with wool, while those that are destined to roam in the frozen regions of the North, are covered with thick fur. Man, however is found in every part of the Globe, maintaining a superiority in his physical, as well as in his moral character over the rest of creation.

The affinity of bodies for Caloric is remarkably weak, as it has a tendency to separate from those bodies that contain it in excess, and combine with any

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then having a smaller quantity, that it comes in contact with, until it is equally distributed, or an equilibrium is produced. This property of Caloric is proved, both in living, and dead matter, but it is obvious, that if living bodies were not possessed of other properties, besides those it holds in common with ⁱⁿorganic matter, life must soon be extinguished in an atmosphere, the temperature of which has been reduced below the freezing point. The living body, however enjoys the power of resisting cold, and preserving nearly the same temperature, under the frozen climate of the Arctic regions as under the burning atmosphere of the Tropic zone, during the most severe winters, and the hottest summer. This power of generating heat exercised by the human body in a state of health, is about 98° of F^{ahr}: birds have a higher temperature, while in cold-blooded animals, (as they are called,) it is lower than in the human body.

There are many remarkable instances on record, which exhibit in a striking manner, this power of the hu-

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man system to resist cold. Mr. Focke in his "View of the Russian Empire," observes, that the inhabitants of that country attend to their ordinary occupations in the open air, with little or no inconvenience, when the thermometer is at 10, 15, or even 20 degrees below the zero of Reaumur; and that women will stand rinsing their faces, through holes in the ice, for four or five hours together, often bare-foot, with their hands dipping in the water all the while, and their clothes stiff with ice. And as Mr. Saint Cooper says, if stronger evidence were wanted, it might be obtained from the histories of persons who have survived the most intense winter cold, in Nova Zembla, in Hudson's Bay, and in Siberia; cold, which caused even the bears to be seen no more; the white fox alone being left with man.

There are many circumstances that render the body more liable to the effects of cold. It acts with much more promptitude on those advanced in life; in whom the action of the heart and arteries is slow and feeble; and whose digestive apparatus does not

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perform its functions with so much vigour, in persons in whom there is a want of nervous energy; inaction of the muscles; and also where the system has been exhausted by previous exertion, or in any state of the system where there is a sensible defect, or diminution of the vital power. People are more liable to its effects during sleep, and convalescence. In the former condition according to Humboldt, the temperature of the body is $1\frac{1}{2}$ degree lower, than when awake. Also in a debilitated state from disease. In such circumstances a degree of cold, (which in other conditions of the system, would produce no deleterious effects,) would in this case, be sufficient to determine the general & local effects of this agent.

On the contrary, in young, and vigorous persons all the functions of the animal economy being perfectly performed, and hence the surface of the body preserving a great degree of vitality; the excess of life developed when the cold is no longer felt renders it capable of powerfully influencing the other

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Habit modifies the effects of cold, hence we find that those persons who are born in Northern countries, and continually exposed to the severity of the weather, are more able to endure its effects, than those habituated to a warmer climate, or who pass the greater part of their time within doors. So that a temperature, which, (to a person accustomed to the operation of cold) would produce no unpleasant effects; in another from a more mild climate, would be followed by a shivering, rigidity, and a degree of immobility, which could only be overcome by a multiplicity of coverings and perseverance in the use of exercise. By the continued application of cold, the cuticle, and true skin become thickened, and serve as a natural covering and protection to the nervous filaments from its painful consequences. This thickening of the skin is very manifest on the hands of sailors, and stage-divers.

or of any other class of persons, whose occupation causes their frequent exposure to the weather.

Temperament, also influences the effects of cold. Persons of the Sanguine temperament, characterized by great activity, and predominance of the Sanguiferous system: a strong, frequent and regular pulse; nervous susceptibility lively &c. are more frequently met with than any other in Northern climates; in fact, it is the necessary consequence of the constant and energetic reaction of the power of the Circulatory system against the effects of external cold. On the contrary, those who are, of what the Ancients called the *Pituitous*, and *Richard* and the Lymphatic temperament, marked by a pale countenance, the flesh soft, and all the vital powers more or less languid; in such persons, cold, in its effects are resisted with less energy, and are more apt to be overcome by its deleterious, and powerful effects.

The application of cold to the body in a moderate degree, instead of proving injurious to its organs, has on

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the contrary, a beneficial, and salutary effect; by concentrating the vital forces, and thereby enabling all its functions to be performed with more vigor and energy. The pulse becomes stronger, and more frequent: the digestive organs perform their office with more energy, and the secretions are increased in quantity. A moderate degree of cold, by thus promoting digestion, and giving activity to the circulation; (according to Richardson, two sources of animal heat) caloric is evolved in greater quantity, to supply the place of that subtracted, and carried off by the air, and surrounding bodies, even before its loss is felt. It is mentioned by some writers that thirst is diminished, while at the same time the appetite is increased. This may be accounted for, by the increase of the secretions; the augmented effusion of the Gastric juice into the stomach promoting appetite: while the increased flow of saliva into the mouth, would naturally have a tendency to obviate thirst. For we see during the hot stage of fever, when the secretions are locked up, and the fauces almost entirely destitute

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of moisture, there is great thirst; but as soon as the secretions are restored, thirst disappears immediately.

Moderate cold, when applied to the body, and attended with a proportionate reaction of the system, produces a tonic effect; thus the same agent that threatens to destroy, at the same time enables the system to resist its deleterious influence.

But when cold is applied of greater intensity, its effects are more apparent. The circulation through the small superficial vessels, is retarded, and weakened, and more particularly in those parts that are remote from the centre of the circulation; as the feet, hands, ears, nose, scrotum &c. parts which have a large surface exposed to the atmosphere, or other frigorific medium, by which the heat is carried off. Cutaneous perspiration is suppressed; the skin becomes pale, and contracts around the piliferous glands and hairs, producing that peculiar roughness, which has been called *Cutis asserina*, from its resemblance to the skin of an unfeathered goose*. There is a general slow

* *Acet. Lyol. ant. cold*

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sation of trembling over the whole body, with frequent agitation of the lower jaw. The fingers are benumbed, and their motions imperfect, and difficult, and even sometimes, impossible, not being obedient to the will. The same is the case with the feet, which also, as well as other parts of the body, contract in size; this diminution of bulk in extreme parts, is said to be so great, that rings, which were tight when the fingers were of the natural temperature, now drop off: and even the shoes fall from the feet.

The forces of the system by degrees exhausting, the reaction bears no proportion to the debilitating powers; the action of the heart and arteries, becomes more feeble: the blood is retarded in superficial parts, more particularly the extremities; whence the skin becomes of a shining violet or bluish colour, and the cuticle is eventually detached. This desquamation of the skin is noticed by Capt Middleton in his Narrative, which contains a minute description of the effects of natural cold, during winter, at Churchill's river.

in Hudsons bay. He says, that notwithstanding this warm clothing, almost every day, some of the men that die abroad; if any wind blows from the Northward, are dreadfully frozen; some have their arms, hands & face frozen in a terrible manner, the skin coming off soon after they enter a warm room.

As there is the strictest connexion between the heart, and brain; the energy of the latter depending on the activity of the former, for the exciting influence of arterial blood. The motions of the heart therefore, being impeded by the continued action of extreme cold, less arterial blood is propelled to the brain, and with diminished velocity; the consequence of which is a numbness, insensibility, and torpor of the whole system: a most insupportable propensity to sleep is felt. The patient lies down, and if not aroused, and kept awake by violent, and unceasing exercise, he sleeps, to wake no more.

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This propensity to sleep, is mentioned by all authors who have written on the subject; and appears to be the usual attendant of excessive cold. Mr. Thompson however, says it is doubtful how far the state of sleep is the necessary consequence of the application of cold simply, and appears to think there must be some other circumstance present, capable of inducing this state. There are many instances recorded of persons having sustained cold for a long time, without inducing much propensity to fall into this state. The remarkable, and interesting case of Elizabeth Woodcock, mentioned by many writers, is the most striking; who, it is said, remained a week buried under the snow, without sleeping a great deal.

Born Laroy, in giving a description of the manner in which the French soldiers perished, from the severity of the Russian climate, states that a

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idiotism, difficulty of speech, or even a total loss of
this faculty, preceded death in them; and that they
continued to march a longer, or shorter time in this
half-lifelong situation supported by their compan-
ions. When separated from the main body of the
troops, they fell into ditches of snow, when a pain-
ful numbness, followed by a lethargic drowsiness,
seized them, which soon terminated their earthly
existence. He also remarks, that frequently before death, there
was an involuntary discharge of urine, and sometimes a haem-
orrhage from the nose. Lacey supposed that it was not
unlikely that the heart, at the final moment was struck
by paralysis, and that the functions of all the organs of life
ceased at the same moment. Others considered the im-
mediate cause of death, to be a congestion, or determination
of blood to internal organs. This, then, would be explain-
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ting, propel the blood to the parts least affected by cold
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duces Apoplexy.

There was formerly much dispute among physi-
cologists, concerning the manner in which cold produ-
ces its effects, or in other words, about its mode of action.
I believe however, that at present, there is but one opi-
nion, viz. that it operates by subducting the animal
heat, which is a general stimulant. Hence by its contin-
uance, all the vital functions, and actions of the sys-
tem, are enfeebled, debilitated, and ultimately arrested.
These are its direct effects, which are obviously sedative.
But, when after having continued for a time, its chill-
ing influence is suspended, or removed, the system
begins to react; the heart and arteries, if not too much
enfeebled by this agent, act vigorously; and the blood,
which before was driven from the surface, and super-
ficial parts, leaving them pale, constricted, and almost
destitute of sensation, now returns; and so increased in
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torrent, that if not moderated by suitable remedies, inflammation, with all its pestilid sequela, never fail to follow in its train. These are the indirect, and stimulating effects of cold.

Cullen divided its effects into Stimulant, Tonic, and Sedative, but this division must have arisen from his confounding the direct, with the indirect effects; so that when he speaks of its stimulant power, he means its indirect action, or the consequences which subsequently result in the ordinary temperature of the atmosphere, after the cold has resigned its place to a more congenial warmth. But, although it is generally admitted, that the operation of cold is directly Sedative, and indirectly Stimulant, it appears to be equally true, that it has a different action, which is directly Stimulant. This is exemplified by the practice of sprinkling cold water on persons in a state of syncope, or Convulsions. Whether the cold, here, or simply the water by its mechanical impulse, contributes to reestablish the contrac-

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tions of the heart, that had been staid, or weakened, is not, I believe, well understood; it is considered by some however, to operate in the latter way merely.

A question of great importance has been agitated by medical men, — whether the human body can ever be restored, after having been frozen. Richter says that it is not, at all, impossible for a recovery to take place, "when the blood in the head itself is not turned to ice, when this organ, and large bloodvessels still retain a degree of vitality; and there is no extravasation in the brain to render the thing impracticable." And he further asserts, that persons who have lain in a frozen state as long as four, or six days, have been restored to life. Mr. Saml Cooper however thinks, and in my opinion, very justly, that Richter must be in error; and that the cases of recovery he mentions, were only instances, in which there had been a suspension of sensation, and voluntary motions,

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The experiments of Mr. John Hunter are alone sufficiently conclusive on this point. He exposed cats to the influence of a freezing mixture of the temperature of 10° Fohr, and succeeded in freezing them, but life was thereby extinguished - They did not recover. A dormouse was also the subject of his experiments; this he found great difficulty in freezing; so vigorous were its powers of generating, and conducting heat, and such the nonconducting quality of its hair, that he did not succeed, till he had first wet it; life was also destroyed in this instance. His conclusion therefore, is "that an animal must be deprived of life, before it can be frozen."

The indications to be pursued in the treatment of Asphyxia from Cold; are first, to restore heat to the body; and secondly, to excite respiration, and restore the circulation.

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It is advised that the patient be brought into a well ventilated room, and rubbed gently with flannels imbued with stimulating substances, and that frictions, should be applied ^{partic} particularly to the Epigastric region, whilst his feet and legs remained in the mean time immersed in warm water. Doctor Currie recommends a bladder of warm water to the pit of the stomach. Aitlie advises frictions of Aqua Ammonia over the Epigastric region. To assist these, we may also apply Volatile Alkali to the nostrils. As soon as sensibility is sufficiently restored, and the patient is able to swallow, stimulating drinks, as brandy and warm wine &c. should be given in small quantities, and frequently repeated. Cooper recommends injections of warm wine.

If the reaction should be so violent as to produce fever, this should be subdued by remedies applicable to that condition.

By some it is recommended, that the patient

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instead of being brought into a warm room, be placed in a low temperature, and rubbed with ice or snow, or even immersed altogether in snow, or ice-cold water, for the purpose of restoring heat more gradually, and of thus guarding against the effects of too violent a reaction, by premature, or too sudden application of heat. But Doctor Helle has suggested the propriety of making a distinction between the effects of cold on the system generally, as producing torpor or Asphyxia; and its local effects on a limb, producing Frost-bite. In the latter state, the powers of the system remain more easily excitable; if heat therefore under these circumstances be applied too suddenly to a part that is frozen, inflammation and gangrene will be the result. But in the other case, where the system generally, feels the sedative effects of cold, all the vital powers are suppressed. In this case so forceful an action is not so likely to arise, nor destruction of parts to ensue from premature stimulation, as all the sensorial functions

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The Local effects resulting from the application of cold to superficial parts depend on the degree of its intensity. When portions of the body are exposed to cold, they become of a red colour; and according to Thompson, from a turgescence of their bloodvessels, we always find a slight increase of volume; after a time the parts assume a blue, or violet tinge. Where the cold is more intense, the members which are usually puffed, as the nose, ears &c become very pale, though the person himself is not at all times aware of what is going on, until warned by some one present. There is a stiffness, and numbness attending this change of colour — in some cases however, there is pain, even during exposure.

If under these circumstances there be a sudden transition to heat, from the patients going into a warm room, or near a fire; a tingling, itching sensation is produced; and is often increased to an intense glow, with pain. This being

permitted to go on
This is Thompson
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permitted to go on, inflammation is often the consequence. This is Thompson's first species of Frost-bite, his second is where vesication, suppuration, or ulceration takes place.

These phenomena are produced by a moderate degree of cold, followed by the application of heat. Richter was the first, who explained that these appearances were not owing to the direct application of cold, but to the reaction that takes place in the system. They are the secondary, or indirect effects of a reduction of temperature. Cold is therefore no more than the predisposing cause of Chilblains. This is confirmed by Larey, who gives many facts which show that inflammation is excited by the sudden change from a cold to a warm temperature. During the Russian expedition, the weather was remarkably cold, yet although the thermometer fell from 20, to 30 degrees below the freezing point of F^{ahr} none of the soldiers experienced any inconvenience, but as soon as the thermometer rose to 6 or 8 degrees

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above the freezing point, many began to complain of acute pain in their feet, numbness of their extremities &c. &c. &c. as a slight redness was perceptible about the base of the toes, and upper part of the foot; the toes being deprived of heat, soon became of a black colour, and hard consistence.

When a very intense degree of cold is applied: the vitality of greater or less portions of the extreme, or superficial parts, is either immediately destroyed, by the direct action of cold; or gangrenous inflammation is excited, and sphacelus is the consequence.

Although much difference of opinion exists among writers with respect to the treatment of persons whose the whole system is affected by cold: there appears to be none, whose parts only are subjects of its influence. As it has been shewn the sudden application of heat to frost-bitten parts never fails to occasion inflammation, and gangrene; it is indispensably necessary, that a due regulation of the temperature should be particularly attended to. Warmth should be restored to the part

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very gradually. It is directed that the affected limb be rub-
bed with snow, or ice, or immersed in very cold water,
the temperature of which may be afterwards gradually
raised. As soon as action, and returning sensation is per-
ceived, frictions with flannel wet with brandy, or cam-
phorated spirits should be substituted. The patient
should be placed in bed, and perspiration induced
by warm drinks.

If these means are judiciously applied, the part
will be gradually restored to a healthy state, but if used
be too suddenly applied, it may terminate in a chronic
inflammation, which will require stimulants, as Luni-
atic acid - Luniatic of Ammonia, Spirits of Turpentine,
Balsam of Copraiva &c.

If mortification should be the consequence, it must be treat-
ed in the same manner, as when it arises from other causes. Dr. Ja-
sey advised the application of blisters to hasten the separation
of the dead parts, and the ulcers left after the separation of the
sloughs, to be treated with Balaicum, rendered stimulating
by the addition of Spirits of Turpentine.

1873

1874

Received of the
University of Cambridge
the degree of
Bachelor of Medicine

Medical Faculty
of the

University of Cambridge

Ref 2

Doctor Lane

Inauguration

Submitted

Mr.

Univers